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GUY P. JONES
EDITOR

Mussel Poisoning—A Summary

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The paralytic form of shellfish poisoning, or "Mussel Poisoning" for short, is a severe form of food intoxication caused by eating mussels or clams at certain times of the year.

Source of Poison: The original source of the poison is found in a unicellular microscopic organism of the ocean, the dinoflagellate *Gonyaulax catenella*. It is a free-swimming organism, multiplying by formation of chains of 2, 4 or even 8 individuals, of dark orange or greenish brown color, and living, like a true plant cell, by photosynthesis. Like all plankton organisms it is most abundant in the summer; at times it may multiply to as large a number as 40 millions per liter. At such times the water may, for miles, present a deep rust red color, the so-called "red water," in day time, and a beautiful luminescent spectacle at night. Needless to say, other dinoflagellates or diatoms may present similar pure culture developments in the ocean without being poisonous. *Gonyaulax catenella* may vary considerably in its poison content; even a small number which is not visible as red water may be sufficient to cause dangerous conditions in shellfish. It occurs in the open Pacific Ocean, less in inclosed bays and estuaries, from Alaska to Southern California. It has been tentatively identified in the North Atlantic Ocean (Nova Scotia and Belgium).

The strong radiation of the sun together with the cold nutrient waters due to the upwellings along the Pacific Coast in summer time seem to be the ideal conditions for the growth of this dinoflagellate.

The Poison: The poison contained in this organism is one of the strongest known. It belongs to the class of alkaloids, such as strychnine, muscarine and aconitine. It is heat-stable in acid or neutral solution, but is gradually destroyed by boiling with alkali. It is readily soluble in water and alcohol, insoluble in ether or chloroform. About one millionth of a gram is sufficient to kill a mouse on injection; the fatal dose by mouth for a man is probably a few milligrams. The toxic principle has not been isolated in a crystalline state but has been purified to a high degree in the form of its hydrochloride.

Toxicity in Shellfish: The plankton serves as a food for many animals of the seashore, including the bivalves. After the mussels ingest the plankton the *Gonyaulax* poison is stored in their digestive glands. The poison is not harmful to the mussels. The resulting toxicity is proportional to the number of *Gonyaulax* ingested and to their alkaloid content. If a large number of *Gonyaulax* is present in the water the toxicity of the mussels may rise to dangerous levels within a few days. In the absence of

the organisms the stored poison is slowly excreted by the mussels in the course of several weeks. The muscular tissue (white meat) of the shellfish does not contain much poison; practically all of it is concentrated in the digestive gland (the dark central portion of the mussel).

Shellfish Affected: All plankton feeders may at times become poisonous. The ones which reach dangerous levels of toxicity and may therefore become a public health problem are mussels and clams. Ocean mussels (*Mytilus californianus*) have caused most of the cases. The large varieties of clams which live near the open Pacific Coast, the Washington and the Pismo clams, are also responsible for several fatalities. The other varieties of clams and the Pacific oyster have never caused any cases although the poison has been demonstrated in most of them. Only shellfish whose habitat is far from the open ocean, such as soft-shell clams, native oysters and scallops, are entirely free of poison. Abalones as well as crabs do not feed on plankton, nor are their viscera consumed; for both these reasons there is no danger of shellfish poisoning from this sea food.

Distribution: Shellfish poisoning is by no means of recent origin. It has been known and recognized in Europe for over 100 years. The first outbreak recorded from the Pacific Coast in white people took place in the exploring party of Captain Vancouver in 1793, on the island which now bears his name. Since 1927 the records for the Pacific Coast show 346 cases of mussel and clam poisonings, with 24 deaths. Most of these occurred along the central California Coast, with a sprinkling of severe outbreaks from Juneau, Alaska, to Southern California and the Gulf of California, Mexico. All cases occurred between the fifteenth of May and the fifteenth of October. In July, 1936, an outbreak with two deaths occurred from mussels of the Bay of Fundy, Nova Scotia.

Considering the large amount of shellfish consumed, even in summer time, the incidence of paralytic shellfish poisoning is, no doubt, exceedingly small; but the dangerous nature of the poison and the high mortality make it a serious public health problem.

Symptoms: The symptoms of mussel poisoning in man or animal are entirely of nervous origin and may set in immediately after the meal. A prickly feeling in the lips, the tongue and the finger tips, followed by numbness are the first signs of intoxication. An ataxic gait and muscular incoordination, and finally ascending paralysis mark the progress of the intoxication, with death from respiratory failure in from 2 to 12 hours after consumption of the toxic shellfish. Symptoms of the alimentary canal are

rare, with exception of vomiting which may occur in severe cases. Small amounts of poison, which are commonly ingested during times of low toxicity, apparently have no effect on the human body. The substance seems to be readily excreted.

Diagnosis: The diagnosis of the paralytic form of shellfish poisoning is, therefore, not difficult, particularly if the history is known. Suspected shellfish material or stomach contents should be sent, in alcohol, through the local Health Department, or directly to Hooper Foundation, San Francisco, for confirmatory tests. There is no simple visual test by which toxic shellfish may be distinguished from harmless ones. Inoculation of extracts into mice is the most reliable testing method. Another simple and dependable test consists of feeding shellfish viscera to kittens. If the kittens do not die in a few hours, provided they retain the food, the shellfish can be eliminated as the cause of poisoning in humans.

Treatment: No specific treatment or antidote for mussel poisoning is known. Therapy can be only symptomatic and should follow the course of treatments in other alkaloid poisonings. Experience during the 1939 outbreak has shown that provocation of active vomiting by apomorphine is more effective in removing pieces of shellfish from the stomach than lavage. Mussel poison is strongly absorbed on charcoal, Lloyd's reagent and similar absorbents. Alkaline fluids are indicated considering the instability of the poison in that medium. In severe cases artificial respiration should be resorted to.

Prevention: The prevention of shellfish poisoning should be educational and legislative. The plain fact that the viscera of any bivalves during summer time may be a potential source of poison should be readily understood. Therefore a safe rule is: *Do not eat the viscera (dark meat) of, nor drink the juice from mussels, clams or similar shellfish from the open Pacific Coast between the first of May and the first of November.* The white meat must be thoroughly washed before cooking. The addition of baking soda in cooking shellfish, which has been advocated, helps to reduce the toxicity but is no safeguard against poisoning if highly toxic whole shellfish are prepared.

For the past 12 years the Health Department of the State of California has taken measures to prevent the occurrence of shellfish poisoning. Mussels being the most common source of the poison are put under quarantine from June 1st to October 1st, and at such other times as laboratory tests show them to be dangerous. Clams of a certain locality are quarantined only when findings in the field or the laboratory have demonstrated highly toxic mussels nearby. It

has never been found necessary to quarantine bay mussels (*Mytilus edulis*), mud clams or oysters.

During the poison season of 1939 it was proven beyond doubt that *warning signs posted along the beaches and across the highways at County lines have a decided effect in reducing the number of cases of poisoning.* The same applies to publicity in the local press and through radio stations along the coast. The health officer or local physician has an excellent opportunity to dispel in the minds of the people the many erroneous notions concerning the cause of mussel poisoning. (1) The paralytic shellfish poison is no post-mortem product. (2) Temporary exposure to the sun does not harm living mussels, nor does it make them poisonous. (3) Mussels below the tide line are, if anything, more poisonous than those above the water. (4) Copper in the rocks, oil on the beaches or pollution of the water are in no way connected with mussel poisoning. (5) Toxic mussels or clams can not be distinguished from normal ones without animal tests. (6) Discoloration of a piece of garlic or of a silver spoon in the pot are no indicators for poisonous mussels.

Instead, the *simple story of the "Chain of Intoxication,"* from the microscopic plant through the cold-blooded animal to man, should readily find its way into the minds of the people along the coast and help to clear up this type of food poisoning.

LITERATURE

Arch. Path., 24: 537-598, 1937, and unpublished results.

DR. MACKAY APPOINTED TO BOARD

Governor Olson has appointed Dr. Eaton M. MacKay of La Jolla as member of the State Board of Public Health to fill the unexpired term of Dr. Frank B. Young of Long Beach, who died late in March.

Dr. MacKay, who was formerly at the Rockefeller Institute for Medical Research in New York City, is now Director of Research at the Scripps Metabolic Institute.

MEXICAN LOBSTERS

Through joint operation with the U. S. Food and Drug Administration protective activities were carried on in the control of live lobsters shipped from Mexico into California. Truckloads bearing good and passable stock are regularly disposed of in southern markets. Dead, sick and decomposed lobsters are immediately destroyed by spraying with kerosene. The product is highly perishable and requires rapid handling.

OLIVE OIL IMITATORS PROSECUTED

The olive oil situation in California is highly disturbed because of the European war conditions. Rigid supervision by the Bureau of Food and Drug Inspection of the manufacturing, labeling and sale of the commodity has been made necessary. The stemming of illicit and nefarious trends in the sale of imitation and mislabeled products was continued during the month. Two individuals were arrested and jailed in Los Angeles for selling adulterated olive oil, represented as pure olive oil. It was offered to wholesalers and retailers in five-gallon cans. Five thousand dollars worth of this spurious product was purchased and distributed by the dealers. The sale of five-gallon cans which actually contained half olive oil and half cottonseed oil to itinerant peddlers who believed the material to be pure olive oil resulted in the further adulteration by the peddlers, whose products contained 25 per cent olive oil and 75 per cent cottonseed oil. In some cases, peddlers were actually selling as pure olive oil a product that contained less than 12½ per cent olive oil.

Prosecutions were also conducted in San Bernardino and in Yolo counties. Fines totaling \$450 were assessed, upon the conviction of peddlers for sale of adulterated oil in the Sacramento area. In San Joaquin County two joint defendants who sold imitation olive oil as pure olive oil were fined a total of \$2,050. Approximately 4,375 gallons of imitation olive oil shipped from the East have been placed under quarantine in California.

WINES IMPROVE

In spite of greatly increased production of wines, estimated at 38 per cent for the year, a relatively small amount has been found substandard. Most wineries of the State now produce only standard wines. Occasionally a substandard product is found but not often.

MORBIDITY

Complete Reports for Following Diseases for Week Ending April 19, 1941

Chickenpox

1251 cases: Alameda County 4, Alameda 4, Berkeley 46, Emeryville 2, Oakland 145, Pleasanton 2, San Leandro 6, Plymouth 18, Contra Costa County 6, El Dorado County 2, Placerville 1, Fresno County 25, Fresno 13, Sanger 2, Holtville 1, Kern County 21, Delano 2, Kings County 16, Corcoran 5, Hanford 12, Los Angeles County 67, Burbank 8, Alhambra 1, Compton 1, El Segundo 3, Glendale 5, Huntington Park 1, Inglewood 2, Long Beach 12, Los Angeles 155, Montebello 1, Pasadena 25, San Fernando 3, Santa Monica 3, Whittier 3, Gardena 1, Marin County 1, Mill Valley 1, San Anselmo 20, Sausalito 1, Merced County 10, Merced 1, Pacific Grove 1, Orange County 42, Anaheim 9, Brea 3, Fullerton 2, Santa Ana 20, La Habra 5, Placentia 4, Tustin 1, Riverside County 2, Banning 6, Indio 1, Palm Springs 3, Sacramento County 5, Sacramento 112, Hollister 10, San Bernardino County 5, San Diego County 8, National City 5, San Diego 84, San Francisco 115, San Joaquin County 13, Lodi 1, Stockton 16, San Luis Obispo County 10, Paso Robles 2, San Luis Obispo 1, Burlingame 4, Redwood City 1, San Bruno 1, San Mateo 1, Santa Barbara County 6, Santa Barbara 1, Santa Maria 1, Santa Clara County 11, Palo Alto 2, San Jose 8, Vallejo 1, Sonoma County 4, Santa

Rosa 9, Stanislaus County 2, Modesto 27, Oakdale 3, Sutter County 1, Corning 2, Tulare County 3, Exeter 2, Porterville 1, Sonora 3, Yolo County 3, Winters 3, Woodland 6.

Diphtheria

16 cases: Alameda County 1, Fresno 2, Humboldt County 1, Los Angeles County 4, Long Beach 1, Stockton 1, Watsonville 1, Modesto 1, Tehama County 1, Oxnard 3.

German Measles

1017 cases: Alameda County 3, Alameda 10, Berkeley 52, Emeryville 1, Livermore 1, Oakland 13, Pleasanton 5, Amador County 20, Colusa County 1, El Dorado County 5, Placerville 3, Fresno County 7, Fresno 6, Eureka 2, Kern County 7, Kings County 1, Lassen County 1, Los Angeles County 46, Alhambra 1, Burbank 5, Compton 3, El Monte 3, Glendale 13, Huntington Park 2, Long Beach 43, Los Angeles 63, Montebello 3, Pasadena 14, Pomona 1, Santa Monica 2, Sierra Madre 1, South Pasadena 2, Lynwood 1, South Gate 2, Maywood 2, Marin County 4, Mill Valley 5, San Anselmo 2, Sausalito 7, Yosemite National Park 3, Point Arena 1, Monterey County 6, Carmel 2, King City 1, Pacific Grove 1, Salinas 1, Napa County 4, Napa 32, Orange County 24, Anaheim 22, Brea 5, Fullerton 2, Huntington Beach 4, Orange 3, Santa Ana 18, Laguna Beach 7, Tustin 1, San Clemente 2, Riverside County 4, Elsinore 1, Perris 6, Riverside 1, Sacramento 30, San Bernardino County 1, Redlands 1, San Bernardino 1, San Diego County 24, Coronado 2, Escondido 28, La Mesa 4, National City 9, Oceanside 3, San Diego 169, San Francisco 26, San Joaquin County 5, Stockton 5, San Luis Obispo County 22, Paso Robles 22, San Luis Obispo 4, Burlingame 8, Daly City 1, Redwood City 1, San Mateo 4, San Carlos 1, Menlo Park 4, Santa Barbara County 12, Lompoc 3, Santa Barbara 4, Santa Maria 14, Santa Clara County 5, Gilroy 2, Palo Alto 4, San Jose 6, Watsonville 12, Shasta County 3, Solano County 5, Sonoma County 19, Petaluma 7, Santa Rosa 5, Modesto 1, Tulare County 1, Sonora 1, Ventura 1, Davis 3.

Influenza

331 cases: Los Angeles County 55, Burbank 1, Glendale 1, Huntington Park 1, Inglewood 1, Long Beach 12, Los Angeles 14, San Gabriel 218, Whittier 1, Lynwood 1, Bell 2, Mendocino County 13, San Diego 1, San Francisco 2, Santa Clara 1, Watsonville 1.

Malaria

2 cases: Oroville 1, Santa Ana 1.

Measles

289 cases: Alameda 3, Oakland 12, San Leandro 1, Chico 4, El Cerrito 1, Pittsburg 1, Placerville 1, Fresno County 3, Sanger 5, Eureka 1, Kern County 6, Kings County 1, Hanford 1, Los Angeles County 26, Alhambra 1, Burbank 1, El Monte 3, Glendale 2, Huntington Park 5, Long Beach 5, Los Angeles 51, Monrovia 2, Pomona 1, Redondo 1, Santa Monica 1, South Pasadena 4, South Gate 5, Monterey Park 1, Bell 3, Modoc County 8, Alturas 8, Monterey County 5, Monterey 1, Pacific Grove 2, Salinas 1, Napa 4, Orange County 2, Newport Beach 1, La Habra 1, Plumas County 1, Banning 2, Riverside 2, Sacramento County 5, Sacramento 6, San Bernardino County 2, Redlands 3, San Diego County 7, Coronado 3, Oceanside 1, San Diego 1, San Francisco 13, San Luis Obispo County 3, Arroyo Grande 1, Paso Robles 3, Burlingame 2, San Mateo 1, Santa Barbara County 1, Santa Barbara 2, Palo Alto 2, Watsonville 1, Solano County 3, Vacaville 2, Vallejo 5, Sonoma County 4, Santa Rosa 1, Stanislaus County 1, Corning 2, Tulare County 1, Ventura County 4, Oxnard 1, Santa Paula 1, Yolo County 2, Winters 2, Woodland 2, California 1.*

Mumps

813 cases: Alameda 7, Oakland 24, Chico 1, Walnut Creek 1, Imperial 1, Kern County 15, Delano 5, Kings County 1, Corcoran 1, Lassen County 1, Los Angeles County 60, Alhambra 2, Arcadia 1, Burbank 1, Claremont 2, Compton 3, El Segundo 1, Glendale 6, Huntington Park 10, Inglewood 2, Long Beach 13, Los Angeles 63, Montebello 3, Pasadena 3, Pomona 11, San Gabriel 2, San Marino 1, Santa Monica 1, Whittier 16, Lynwood 1, South Gate 1, Monterey Park 1, Maywood 3, Bell 6, Madera County 6, Madera 1, Monterey County 2, Monterey 5, Salinas 1, Napa 8, Orange County 21, Anaheim 1, Brea 5, Fullerton 7, Newport Beach 18, Santa Ana 23, La Habra 41, Riverside County 4, Blythe 1, San Jacinto 2, Indio 11, Sacramento 8, San Bernardino 2, San Diego County 8, National City 2, La Mesa 9, San Diego 84, San Francisco 72, San Joaquin County 1, Paso Robles 4, Santa Barbara County 4, Santa Barbara 48, Santa Clara County 4, Mountain View 2, San Jose 9, Santa Clara 1, Dunsmuir 1, Solano County 4, Sonoma County 13, Santa Rosa 2, Stanislaus County 3, Tehama County 1, Corning 22, Tulare County 33, Exeter 1, Ventura County 19, Oxnard 1, Santa Paula 1, Ventura 3, Ojai 3, Yolo County 2, Winters 12.

Pneumonia (Lobar)

49 cases: Berkeley 1, Oakland 3, Kern County 1, Bakersfield 1, Los Angeles County 8, Alhambra 1, Glendale 1, Huntington Park 1, Long Beach 2, Los Angeles 10, Santa Monica 2, South Gate 2, Monterey Park 1, Monterey County 1, Pacific Grove 1,

* Cases charged to "California" represent patients ill before entering the State or those who contracted their illness traveling about the State throughout the incubation period of the disease. These cases are not chargeable to any one locality.

Napa County 1, Riverside 1, San Bernardino County 1, San Diego County 1, Oceanside 1, San Diego 1, San Francisco 1, Paso Robles 1, Sonoma County 1, Petaluma 1.

Scarlet Fever

112 cases: Berkeley 2, Oakland 6, Gridley 4, Walnut Creek 1, Del Norte County 1, Sanger 4, Kern County 1, Bakersfield 1, Kings County 1, Los Angeles County 12, Burbank 1, Culver City 1, Inglewood 4, Los Angeles 35, Pasadena 1, Whittier 1, Lynwood 2, Merced 1, Orange 1, Santa Ana 2, Plumas County 1, San Bernardino County 1, San Bernardino 1, San Diego County 1, San Diego 6, San Francisco 6, San Joaquin County 1, Stockton 1, Santa Barbara 1, San Jose 1, Sonoma County 1, Sutter County 2, Tehama County 1, Tulare County 1, Fillmore 1.

Smallpox

No cases reported.

Typhoid Fever

2 cases: Pacific Grove 1, Orange County 1.

Whooping Cough

654 cases: Alameda County 4, Alameda 5, Berkeley 19, Livermore 2, Oakland 41, Pleasanton 1, Butte County 3, Colusa County 4, Contra Costa County 1, Martinez 12, Fresno County 10, Fowler 1, Fresno 2, Holtville 1, Kern County 23, Kings County 5, Corcoran 1, Hanford 2, Lassen County 2, Los Angeles County 65, Alhambra 1, Burbank 1, Compton 1, Culver City 1, Glendale 5, Hermosa 1, Inglewood 4, Long Beach 17, Los Angeles 46, Pasadena 11, Pomona 2, San Fernando 1, Santa Monica 17, South Pasadena 1, Torrance 2, South Gate 4, Maywood 3, Bell 2, Madera County 1, Yosemite National Park 1, Merced County 2, Monterey County 6, Napa 2, Orange County 61, Anaheim 4, Brea 3, Fullerton 1, Orange 2, Santa Ana 7, La Habra 4, Laguna Beach 15, Perris 1, Indio 1, Sacramento County 2, Sacramento 38, Redlands 2, San Bernardino 4, San Diego County 11, La Mesa 1, National City 2, San Diego 71, San Francisco 19, San Joaquin County 10, Lodi 6, Stockton 3, San Luis Obispo County 12, San Mateo 2, Santa Barbara 1, Santa Maria 3, Santa Clara County 1, Sunnyvale 3, Santa Cruz County 2, Solano County 1, Sonoma County 1, Petaluma 1, Stanislaus County 8, Modesto 1, Oakdale 3, Tehama County 1, Red Bluff 2, Ventura County 5, Yolo County 2, Winters 1.

Meningitis (Epidemic)

5 cases: San Bernardino 2, San Luis Obispo County 1.

Dysentery (Amoebic)

2 cases: Claremont 1, San Mateo 1.

Dysentery (Bacillary)

7 cases: Imperial County, Los Angeles 2, Pasadena 1, Maywood 1, Monterey County 1, Sonoma County 1.

Poliomyelitis

One case: Oakland.

Tetanus

One case: Los Angeles.

Trachoma

2 cases: Fresno 1, Los Angeles 1.

Trichinosis

8 cases: San Leandro 2, Tulare County 5, Porterville 1.

Food Poisoning

40 cases: Los Angeles 34, San Francisco 2, Stockton 4.

Undulant Fever

5 cases: Kern County 2, Kings County 1, Los Angeles County 1, Sutter County 1.

Septic Sore Throat

2 cases: Sonoma County 1, Stanislaus County 1.

Epilepsy

26 cases: Oakland 2, Fresno 4, Los Angeles County 3, Los Angeles 12, San Bernardino County 1, San Francisco 1, Sonoma County 3.

Rabies (Animal)

14 cases: Imperial County 5, Huntington Park 1, Madera County 1, Chowchilla 1, Lincoln 1, San Bernardino 1, San Diego County 1, La Mesa 2, Redwood City 1.

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